[Proc. Roy. Soc. Victoria, **46** (N.S.), Pt. I., 1933.]

Art. VI.—*On Fossiliferous Grits and Cherts, presumably of Cretaceous Age, associated with the Nullagines of Western Australia.*

By FREDERICK CHAPMAN, A.L.S., Hon. F.R.M.S., F.G.S.
(Commonwealth Palaeontologist).

(With Plate IV.)

[Read 13th July, 1933; issued separately 22nd December, 1933.]

Introduction.

The following notes are the result of a detailed examination of rock sections and specimens handed to me for description by Professor Sir Edgeworth David, D.Sc., LL.D., F.R.S., during 1930 and 1931. These were accompanied by notes on the occurrence of the rocks, by Dr. E. S. Simpson, and forwarded by the courtesy of Prof. E. de C. Clarke, M.A., to Prof. Sir Edgeworth David.

Besides the rock sections kindly supplied me by Professor David, additional and especially thin micro-sections of the glauconite chert from Davis River have been prepared to show their minute organic structure, as well as others from the limestone of Wongawall. My remarks on the glauconite grit from Spinifex Well are based on the micro-slides prepared in the Geological Department of Sydney University, and kindly lent me by Professor Sir Edgeworth David.

Description of the Rocks.

Davis River, No. 13895.

(These and other numbers were given during the W.A. Survey work, and are recorded in *Bulletin* No. 83, *W.A. Geol. Surv.* 1920, by Mr. H. W. B. Talbot.)

Locality.—"Near Survey Mark CC. 88 (Lat. 22°, S. Long. 121° E., approximately), 205 miles North-North-East of Spinifex Well. Apparent Nullagine beds." E. S. Simpson. Banded glauconite grit. See *Bull.* 83, pp. 62, 126, 170.

Macroscopic Appearance.—A hard siliceous rock with banded structure, consisting of vivid grass-green glauconite layers, about 1 mm. in thickness; alternating with thicker, cherty bands of a pink to brown colour, about 3 or 4 mm. in thickness. This banded structure is more or less platy when fractured, and is clearly the result of an induration of a bedded sediment.

Microscopic Characters.—(*a*) *The Glauconite Bands.*

These consist of angular quartz and other mineral fragments, together with more than 50 per cent. of glauconite grains, which are mostly in the form of casts of the interior of foraminiferal tests. The glauconite grains average about 0.5 mm. across, but occasionally attain three times that diameter. Of the more definite casts some can be referred to Foraminifera of the rotaline kinds, whilst others are related to virguline and globigerine genera. The occurrence of this evidence, apart from any other, tends to support the Cretaceous age of the rock.

(*b*) *The Chert Bands.*

Under a high magnification the cherty layer was seen to be crowded with the curious minute calcareous bordered discs (now silicified), known as coccoliths. They are of comparatively large size and well-preserved. Numerous smaller, hammer-shaped, rhabdoliths, also of supposed algal affinity, are distributed throughout the cherty substance. Other bodies seen in the sections were some (?) felspathic lath-shaped crystals. The largest coccoliths measure 0.02 mm., whilst the average examples are only half that diameter. The coccoliths present are of the type known as discoliths; they agree both in size and structure with those found in the Gin Gin Chalk of Western Australia, but are more numerous than in that particular rock. No cyatholiths were seen.

Coccoliths are not confined to the Cretaceous, but are often numerous, in the southern hemisphere, in Tertiary limestones; they also occur in rocks of the latter age in the West Indies, and are occasionally found in Jurassic marls in Europe. In these occurrences, however, the coccoliths differ in character from the Cretaceous forms.

Spinifex Well, No. 13374.

Locality.—"Spinifex Well is No. 35 on the Stock Route between Nullagine and Peak Hill. It is situated in approximately Lat. 24° 38′ S. and Long. 119° 38′ E., about 7 miles North-East of the now abandoned Kumarina Copperfield." E. S. Simpson.

Note by Dr. Simpson.—"The surrounding country for an indefinite distance to the East, North, and West, is mapped by Talbot (see H. W. B. Talbot, *Geol. Surv. W.A. Bull,* 83, plate VIII.) as horizontal or slightly dipping (up to 30°) beds of the Nullagine series (post-Huronian, pre-Carboniferous), penetrated at Kumarina and elsewhere by dolerite dykes, extending at times into sills. No such dyke or sill was seen in the immediate vicinity of Spinifex Well. Nineteen miles due south

of the well one strikes the northern boundary of a large area of granite. There is some reason to believe that at Kumarina the Mosquito Creek schists (Huronian ?) are not far below the surface Nullagine sediments, which are here gypsiferous shales (see E. S. Simpson, *Journ. Roy. Soc. W.A.*, ix., pp. 45-49), and a small outcrop of them was observed by Talbot at the base of Wonyulgunna Hill, 13 miles South-South-East of Spinifex Well. Topographically, Spinifex Well lies in a broad lowland between outliers of the Collier Range (Nullagine sediments), see H. W. B. Talbot, *Geol. Surv. W.A. Bull.* 83, plate)."

"The well is 60 feet deep, and the spoil on the surface consists of about two parts grey shale and one part glauconite sandstone and grit. There is no record of the relative situation of these two rocks. The immediate surface consists of loose sand."

The above notes were written by Dr. Simpson, and dated 12.11.30. They were originally sent to Sir Edgeworth David, who permits me to quote them. Dr. Simpson also furnished alternative sections showing the relations of the rocks of this locality, and stated that "Two structural explanations are possible, of the visible data;

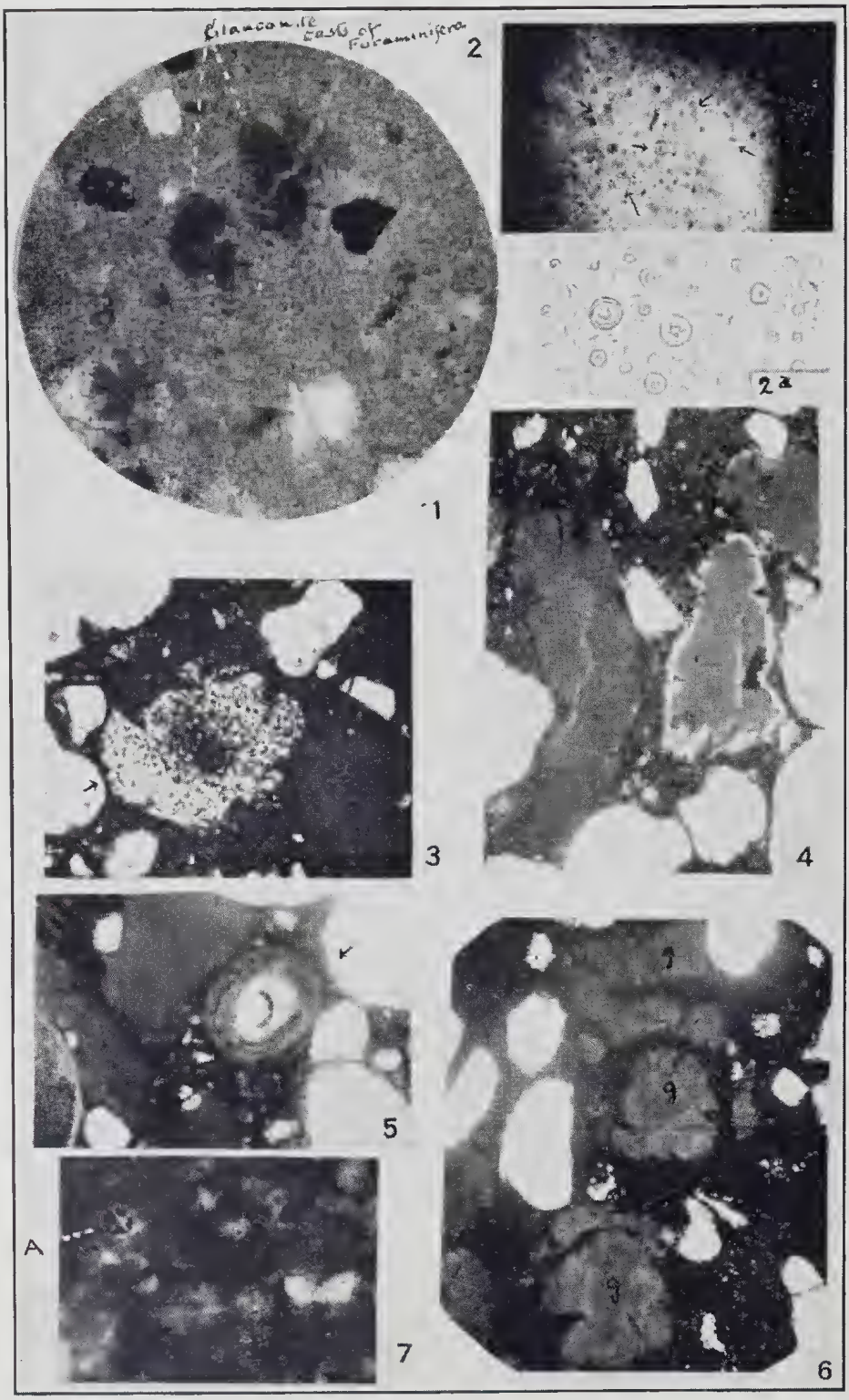
"(1) That the Nullagine sediments extend from the base of the hills across the lowlands either on or immediately below the surface.

"(2) That in the lowlands between the hills the Nullagines have been eroded to some depth, and the hollows levelled off with sediments of much later date.

"Fossil evidence is required to decide between these alternatives, but no fossils have yet been found recorded from Spinifex Well, and the undoubted Nullagine rocks have yielded no fossils whatever from any part of their extensive exposures."

Macroscopic Appearance.—A gritty dark-brown sandstone, with included pebbles of schistose radiolarian rock, jasper and rounded quartz grains, associated with abundant dark green to almost black glauconite grains.

Microscopic Characters.—Matrix scanty, of the nature of a fine siliceous and ferruginous ooze, more or less of foraminiferal and radiolarian origin. The foraminiferal glauconite casts are of larger size than those of Davis River, having an average diameter of 1 mm. They can be referred to rotaline, textularian, and possible milioline forms. One of the grains of finely crystalline quartz was originally a crinoid ossicle, for it shows the central gut canal and the typical crinoidal meshwork structure, now replaced by silica. There is also, in one of the sections, a small oolitic grain with numerous concentric layers, now jasperized. Coccoliths are present, but not abundant.



F. C. photo.]

Sections of Chert and Glauconitic Rocks Associated with Nullagine Beds, W.A.

[*Page 64.*]

This rock has undergone considerable dynamical metamorphism, the finely granular and organic particles forming the paste being crushed to a very fine powder. Moreover, the larger pebbles often show very decided stress-shadows under rotating nicols.

Conclusions.

The glauconite cherts of Davis River are here held to be of Cretaceous age. This is based on the abundance of coccoliths seen in the chertified ooze of this rock, bands of which are interstratified with the layers of glauconite. The latter contain casts of foraminifera, the genera of which are comparable with those occurring in the Gin Gin Chalk of Western Australia.

The gritty green and brown sandstone of Spinifex Well, Kumarina Copper Mine, may be regarded as similar in age, since, besides coccoliths, it contains abundant glauconite casts occasionally recognizable as genera of foraminifera met with in mesozoic faunas. The presence of radiolaria in the finer structures of the rock links them, in generic character, with the siliceous chalk of Fanny Bay, Port Darwin.

Note.—Included in the present collection is a crystalline limestone, of a purplish brown colour, with occasional greenish streaks containing disseminated grains of glauconite. An examination of this rock, which occurs at Lake Carnegie (Wongawall), Western Australia, shows many characters distinct from the rocks dealt with in the foregoing notes, and by the presence of a fossil form, resembling an ? edrioasterid, this limestone may eventually turn out to be of Lower Palaeozoic age. According to Talbot (1920, p. 61) this limestone underlies the surface flaggy and siliceous rocks of the district.

Explanation of Plate IV.

Fig. 1.—Section of glauconite chert, showing casts of foraminifera surrounded by silicified coccolitic ooze. Davis River, W.A. ×28.

Fig. 2.—Section of ditto, more highly magnified, showing coccoliths, ×184.

Fig. 2a.—Enlarged drawing of coccoliths. Circ. 360 diam.

Fig. 3.—Silicified crinoid ossicle in thin section. Glauconite Sandstone Spinifex Well, Collier Range, W.A. ×28.

Fig. 4.—Stretched glauconite cast in sandstone. Spinifex Well, W.A. ×28.

Fig. 5.—Oolitic grain (silicified) in glauconitic sandstone. Spinifex Well, W.A. ×28.

Fig. 6.—Glauconite casts of cf. rotaline foraminifera (marked G) in sandstone. Spinifex Well, W.A. ×28.

Fig. 7.—Fine siliceous radiolarian ooze between mineral grains. Spinifex Well, W.A. A spumellarian form indicated at A. ×184.